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Mathematics Knowledge of Pre-service Teachers for Primary Education and Their Readiness for Practice

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Abstract

This study is focused on knowledge of pre-service teachers for pre-school and primary education. Selected requirements for pupils' knowledge in the fifth year of their schooling are compared with pre-service teachers' knowledge in primary mathematics. As a research tool we applied the mathematical part of an admission test to eight-year grammar school which covers the curriculum of primary mathematics.

Keywords: Knowledge, pre-service teachers, primary education, mathematics.

Classification: D39

Introduction

At the first level of primary school teachers strongly influence how pupils succeed throughout their schooling. They need to teach pupils use mathematical thinking for solving practical problems in everyday situations; appropriate use of ICT for learning, identification of risks associated with the use of the Internet and other media; how to develop critical thinking when working with information; how to apply acquired knowledge of natural sciences and social sciences; to recognize problems at school and in their nearest environment, and finally, how to propose a solution according to their knowledge and experience. (Innovated *State Education Programme for Primary Education*, 2015, page 5) In Slovakia all teachers have to be university graduates and must have appropriate higher education, and pre-school teachers are not an exception. The study programme for pre-school and primary teachers is common in a three-year bachelor degree (called *Pre-school and Elementary Education*). The bachelor diploma authorizes the graduates work as pre-school teachers or tutors for school clubs. University graduates can continue in two-year master degree programme (*Teacher Training for Primary Education*). This programme has to be completed by receiving the teaching qualification (teacher training for primary school).

In primary educational level pupils should achieve the following objectives, focused on mathematics (Innovated State Education Programme for Primary Education – Appendix Mathematics, 2015):

- acquire basic mathematical concepts, knowledge, skills and practices stated in educational standards;

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- perform computations with integer numbers (up to 10,000);
- use fractions in the propaedeutic, preparatory level;
- identify and correctly name of the functional relationships between numbers,
- explore rules within given sequences and continue the sequences;
- orient in tables and charts,
- identify and construct geometric figures specified in educational standards,
- estimate and accurately measure lengths and also convert length units (mm, cm, dm, m, km);
- use mathematics as a tool for finding solutions to real life problems (including development of financial literacy);
- develop skills related to the process of learning; improve cognitive processes and mental operations;
- strengthen positive moral and volition-related characteristics (independence, decisiveness, endurance, tenacity, criticism, self-criticism, confidence in their own abilities and possibilities, systematic problem solving in personal and public contexts);
- develop key competences in social and communication spheres.

At primary school, pupils have *Mathematics* as a school subject one lesson almost every day. The primary mathematical curriculum is divided into five main parts: *Numbers, variable and number operations*; *Geometry and measurement*; *Relations, functions, tables, diagrams*; *Logic, reasoning, proofs; Combinatorics, probability, statistics*.

Pre-service teacher training programmes for pre-school and primary education at universities in Slovakia

One of the nowadays trends is the decreasing number of contact lessons at Slovak universities. This problem negatively impacts each study programme, e. g. decreasing of mathematical content or number of subjects in teacher training programmes for pre-school and primary education.

While future teachers for primary education study at university, they attend various subjects and courses with mathematical content.

We compared the bachelor and master study programmes from five universities in Slovakia. Below, we give an overview of the number of contact hours (Table 1) which cover various branches of mathematics and didactics of mathematics within these programmes.

The subject Didactics of mathematics is included in the master study programme, not earlier. Only one of these universities (J. Selye University) includes the subject Mathematics and Didactics of mathematics in bachelor study programme. The list of subjects for the study of different branches of mathematics contains subjects, such as Introduction to geometry; Mathematical imagination (methodology of its developing); Formation of geometrical imagination; Logic and Set theory; Arithmetic; Didactical games in Mathematics; Development of basic mathematical imagination; Manipulative geometry; Geometry; Primary mathematical education; Elementary Graph theory; Geometric modelling and spatial imagination; Integers, rational and real numbers; Functions and functional thinking; Phylogeny and ontogeny of

Integers; Mathematical literacy; Methodology of Problem solving; Mathematics and work with information; Workshops in mathematics; Mathematical seminars and competitions; Formation of mathematical concept of number, and Basics of mathematics; Amusing tasks.

Table 1: Overview of the number of hours in bachelor and master degree programme of five universities in Slovakia

University	Bachelor degree programme Pre-school and Elementary Education			Master degree programme Teacher Training for Primary Education		
	subjects			subjects		
	compulsory	compulsory-optional*	optional	compulsory	compulsory-optional	optional
Constantine the Philosopher University in Nitra	8	4	0	7	6	0
Catholic University in Ruzomberok	5	1	0	5	2	1
Trnava University in Trnava	3	4	0	12	10	0
Matej Bel University Banská Bystrica	8	4	4	4	2	4
J. Selye University	12	2	0	This university does not provide the master study programme.		

According to the data in the overview we can state that different universities have assigned different number of mathematical preparation lessons and courses for future primary school teachers.

In our opinion higher quality of teacher training is the necessary precondition for quality pupils´ education at various levels of education. Latest national and international measurements of pupils' mathematical knowledge indicate a declining trend. Reducing the number of contact lessons at university would cause further decrease of students' mathematical knowledge as well as their readiness for practice. Therefore, it is important to consider adjustments of the teacher training curriculum in university courses oriented to the primary education.

*Not directly compulsory subject, but students have to select several subjects from a group of compulsory-optional subjects.

The study

For our study we decided to use the mathematical part of admission test to eight-year grammar school in Nitra, Golianova Street 68. Eight-year grammar schools in Slovakia provide lower and upper secondary education. Pupils in the fifth year of their schooling can apply for admission to this study. The main reason for the choice of such test is that the entire primary mathematical curriculum is covered in the test tasks.

We divided the participants into three groups. The first group consisted of 77 pupils who wrote the admission test. The average age of these pupils was 11 years. These pupils were in the end of the fifth year of their schooling. The second group consisted of 88 pre-service teachers, university students of Pre-school and Elementary Education study programme, who were in the end of the second year of a three-year bachelor study programme. These students had completed several mathematical subjects oriented to basics of Arithmetic, Algebra and Geometry which were focused only on mathematical apparatus, without any Didactics of mathematics. The third group consisted of 62 students of Teacher Training for Primary Education study programme who were in the end of the second year of a two-year master study programme. These students had completed all mathematical subjects, including problem solving strategies and didactics of mathematics. It is important to remark that these students were just preparing for state exams and they should start their professional career three months later. We expected them to be familiar with mathematical cognizance and also know how to teach primary mathematics by using appropriate teaching methods and strategies.

The test consisted of two parts. The first part included four tasks: three numeric calculation tasks (two focused on curriculum topic *Numbers, variable and number operations,* one on *Geometry and measurement*) and one construction task to draw a line, circle, square or rectangle, perpendicular line and parallel line. The second part of the test included seven multiple choice tasks: three tasks covering curriculum topic *Numbers, variable and number operations,* one covering *Geometry and measurement* with focus on spatial geometry, one focused on *Relations, functions, tables, diagrams*, one on *Logic, reasoning, proofs,* and one covering *Combinatorics, probability, statistics*.

We have set the following research questions:

Is the average score of the test for university students higher than the average score of pupils in the end of the fifth year of their schooling?

Have the students at the end of their master study better results from the test than students in bachelor study?

Results and discussion

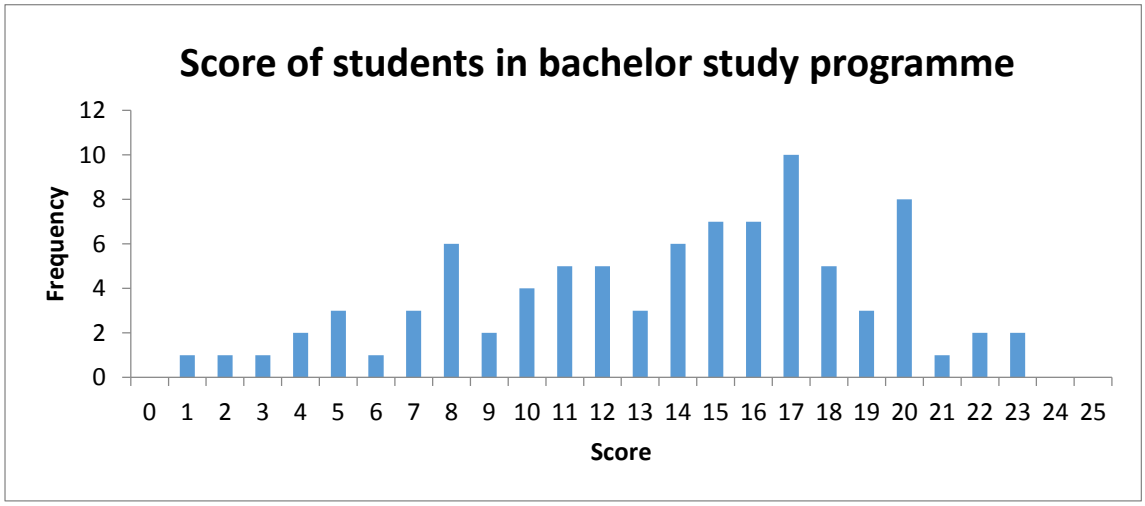
The maximum score of the test is 25 points. The average score of each group of participants is presented in Table 2. The supplemented statistical characteristics are included, too.

The average score of university students is not higher than the average score of pupils in the fifth year of their schooling. Students in master study programme have higher average score than pupils, but the difference in not as significant as we expected.

Table 2

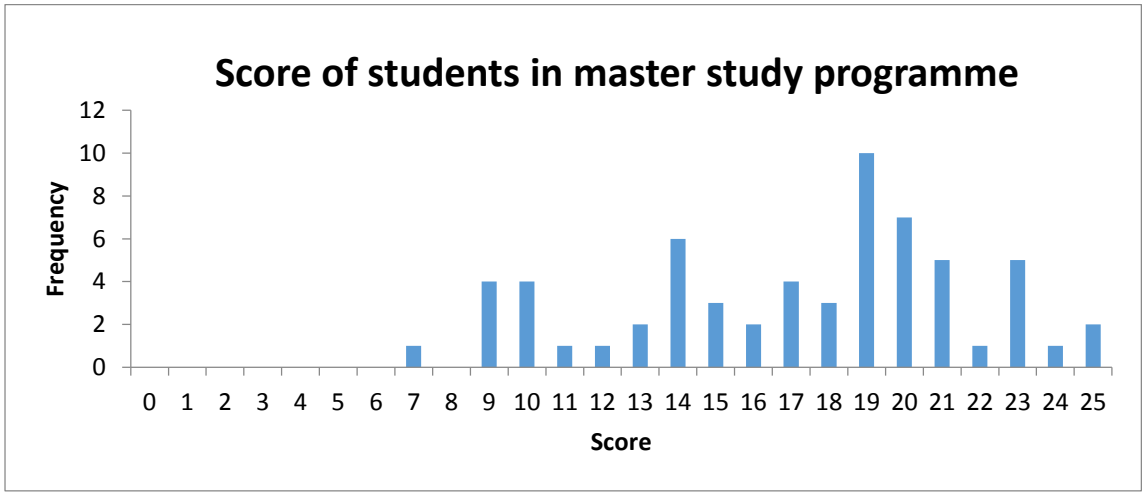
	Pupils who wrote the admission test Pupils in the fifth year of their schooling	Students of Pre-school and Elementary Education Bachelor study programme	Students of Teacher Training of Primary Education Master study programme
Number of participants	77	88	62
Average score	15,17	13,69	17,11
Percentage	60,68 %	54,77%	68,45%
Median	15	14	19
Mode	14	17	19

Graph 1: Histogram of score of students in Pre-school and Elementary Education programme



Students in bachelor study programme have smaller average score than the pupils, but their mode is higher than the pupils' mode. The average score of students in bachelor degree is reduced due to students with extremely low count of points (there were 18 students with 1-8 points, see Graph 1).

Graph 2: Histogram of score of students in Teacher Training for Primary Education programme



Students at the end of their master study have better results from the test than students in bachelor degree, which is an expected result, although we expected much better results (about 90 %) of the master degree students.

Furthermore, the students used solving strategies which are not adequate to the level of primary mathematics. They used formulas and equations with unknown, rule of three and decimal numbers which are not a part of the primary maths curriculum.

Despite their weak results students of the bachelor study programme were grateful for "adjusting a mirror" of their knowledge.

We introduce also the transcript of a dialogue among the students of Pre-school and Elementary Education study programme and the teachers. The dialogue occurred after evaluation of the test:

S_1: *How can I teach pupils these tasks if I don´t know them myself?*

T: Don´t worry about that. If you don´t know it now, you have another three years to the end of Teacher training of primary education programme. Use this time effectively.

Other student:

S_2: At lower secondary schools we were taught to use equations with unknown, rule of three, decimal numbers, fractions and percentages. Now, couldn't we use these strategies in solving task or problems?

T: You can use the whole mathematical apparatus which you have in solutions of tasks or problems during the preparation to education. However, with children you can use only strategies adequate to the curriculum of primary mathematics.

The approach of another student was surprising:

S_3: I will use methods and strategies described in the methodological guide to textbooks. There will be everything what I will need.

T: Not all textbook authors write a methodological guide to textbooks. What will you do if there does not exist any guide to textbooks used in the class?

S3: (Silent)

Comparison of the scores - topics of the primary mathematics

Furthermore, we were interested in which curriculum topic the students had the weakest results. Table 3 shows the percentage of students in each curriculum topic.

After testing the students said that the easiest task was the combinatorial problem. They had difficulties with finding regularity; how to calculate the perimeter of rectangle, and with the task related to spatial geometry.

Table 3

Curriculum topic	Bachelor study programme Pre-school and Elementary Education	Master study programme Teacher Training of Primary Education
Numbers, variable and number operations	57,44 %	72,43 %
Geometry and Measurement	47,28 %	58,06 %
Relations, functions, tables, diagrams	60,23 %	84,68 %
Logic, reasoning, proofs	67,05 %	79,03 %
Combinatorics, probability, statistics	81,82 %	85,48 %

The following examples are the tasks with the lowest success rate in each curriculum topic.

Numbers, variable and number operations

Hedgehog Pichliač and his wife hedgehog Pichličica had a wedding day and they invited 35 hedgehog guests. Among the guests there were adult hedgehogs and young hedgehogs, too. There were 15 less young hedgehogs than adult hedgehogs. How many young hedgehogs were invited to the wedding party?

Geometry and Measurement

Peter glued together 10 cubes in one solid, as shown in Figure 1. Then he coloured the solid with blue colour. After dismantling the solid, how many cubes have three blue faces?

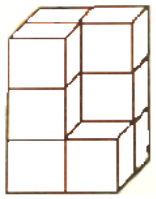


Figure 1

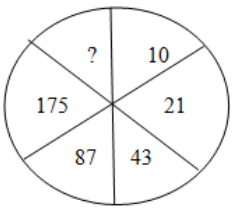
Relations, functions, tables, diagrams

A mole sews trousers for itself and friends. The mole needs 28 dm of cloth for eight trousers. How many trousers can the mole sew from 42 dm of cloth?

A) 6 B) 10 C) 12 D) 15

Logic, reasoning, proofs

Fill in the circle with numbers following the regularity:



A) 351 B) 346 C) 236 D) 216

Combinatorics, probability, statistics

Mark can get to school through three different streets. He always uses a different street on his way from school than he uses on his way to school. How many days can he walk to and from school without repeating his way?

Conclusion

A lot of studies suggest that prospective elementary teachers need to study more mathematics (in Mewborn, 2001). Ball & Wilson (1990) presented the same students' questions as we introduced: *How can I teach if I don't know why myself? We haven't seen these things before and I don't know where I was supposed to learn them – in high school? Or middle school?*

In our opinion, mathematics learning needs to be accompanied by learning adequate problem solving strategies in teacher training study programmes for pre-school and primary education. As we mention in the introduction of this paper, teachers in the first level of primary school often affect how pupils succeed throughout their schooling and within that also he/she affects their attitudes to mathematics. Teachers prepare pupils for various mathematical competitions. Last but not least, teachers at primary school should be able to prepare pupils for admission test similar to the one we used the research tool.

The difference between score of students in bachelor and master degree shows that inclusion of the mathematical subject (including didactical subjects oriented on problem solving strategies) into teacher training programme has its justification. Nevertheless, the score of master students is not satisfactory. Therefore, it is important to consider curriculum adjustment of the teacher training study programme for primary education.

Acknowledgement

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